➤BY BILL KENNEDY, CONTRIBUTING EDITOR

Express Checkout

Upgrades and multifunction technology improve CMM inspections.

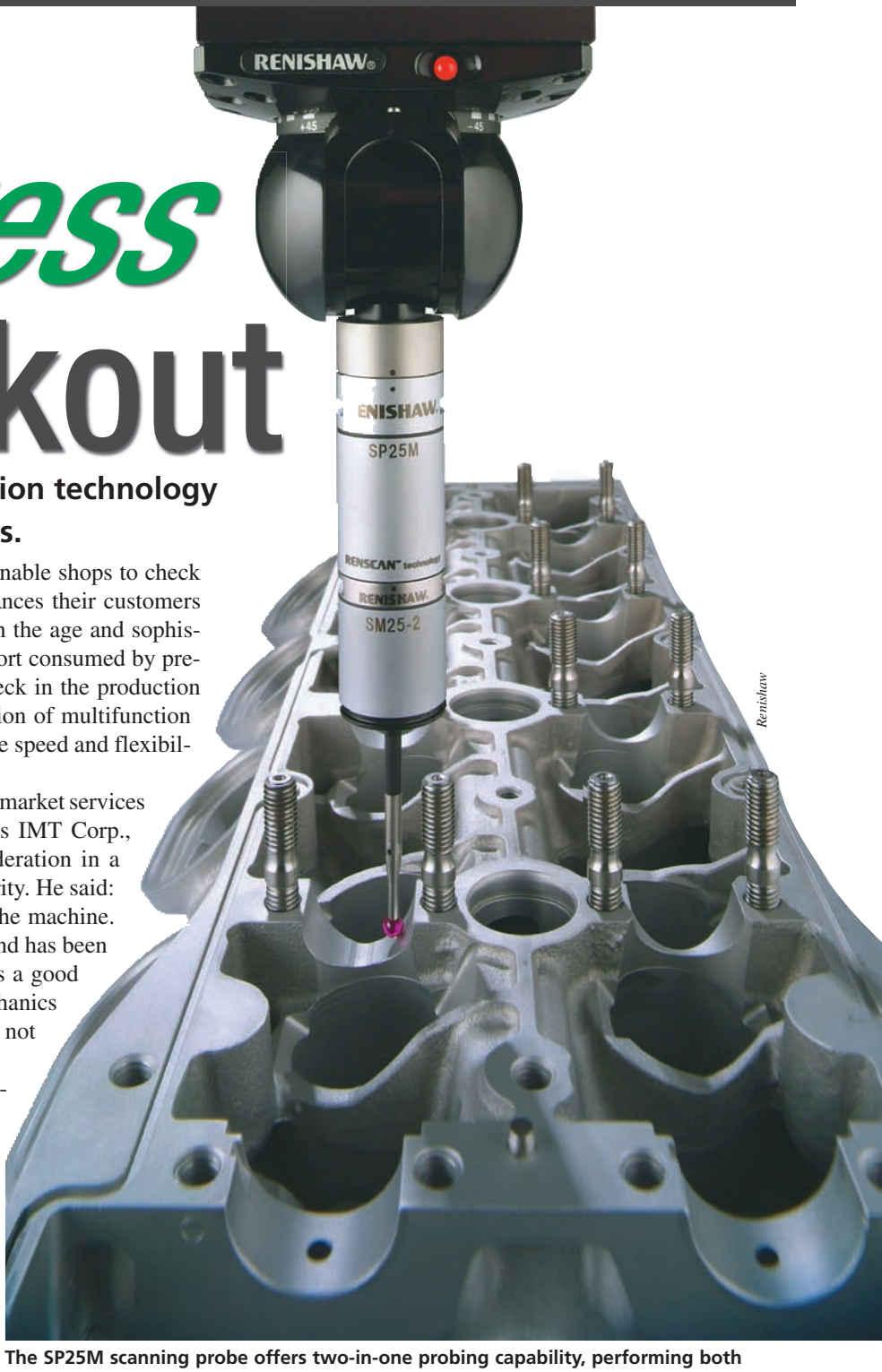
Coordinate measuring machines enable shops to check the increasingly tight part tolerances their customers demand. However, depending on the age and sophistication of the CMM, the time and effort consumed by precision inspection can create a bottleneck in the production process. Selected upgrades and adoption of multifunction CMM technology can help increase the speed and flexibility of inspection routines.

According to Drew Shemenski, aftermarket services software sales engineer for Carl Zeiss IMT Corp., Maple Grove, Minn., the first consideration in a CMM upgrade is its mechanical integrity. He said: "We always look at the condition of the machine. If it is in good mechanical condition and has been kept calibrated and accurate, then it is a good candidate for an upgrade. If the mechanics are shot and it is not accurate, we're not going to improve the situation."

Assuming the CMM is mechanically sound, an economical upgrade would be to replace its metrology software. Software upgrades "are really the backbone of what we do," Shemenski said. A typical example is a shop with a 15-year-old CMM in good physical condition but running a DOS-based computer platform. Shemenski said a Windows-based software retrofit, like Zeiss' Calypso package, lets a shop import CAD files, select areas to be measured and then automatically create measuring programs. The operator-oriented software permits programming offline, so inspection operations can continue while preparing for a new part.

When a shop has different brands of CMMs, upgrading them to a common software package lets operators move from machine to machine more easily. Standardization can also facilitate the addition of CMM equipment, because software can migrate to a new machine.

According to Shemenski, the next step in a CMM upgrade involves the machine's controller. A new controller can boost data-acquisition speed and accuracy, and can also



Renishaw

The SP25M scanning probe offers two-in-one probing capability, performing both scanning of form and touch-trigger sensing of size and position.

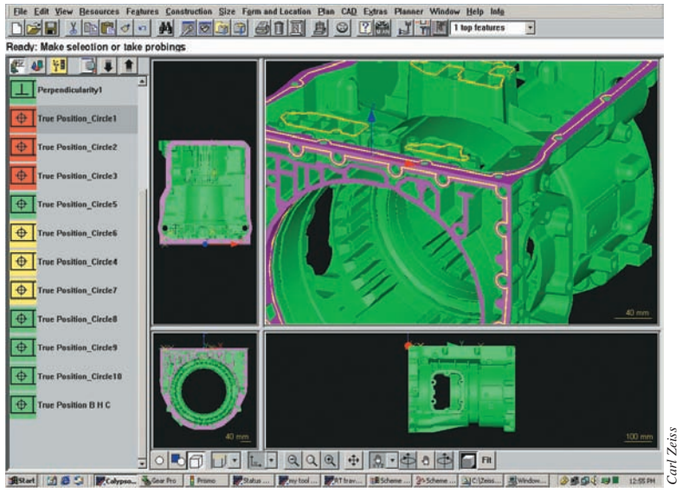
provide information-gathering capabilities, onboard diagnostic capability and predictive maintenance schedules.

Following upgrades of the CMM's software and controller, new probing technology provides further benefits. The classic CMM probe is a touch-trigger device that records a single data point when a stylus contacts a part and activates a switch. Touch probes have evolved to the point that scanning units remain in contact with the part and provide analog feedback, recording many data points continuously and quickly.

Combining new software, controller and probing technologies can significantly boost CMM inspection speeds. Shemenski described Zeiss' Vast Navigator suite of technologies, which is available on new machines in the Zeiss High Performance class of CMM. The Navigator package includes advanced logic for the machine controller and a specialized probe head, and the software incorporates features that scan the part faster and gather data quicker, Shemenski said. "We did tests using a V-6 engine block that took 22 minutes to run for a particular inspection. When we used Navigator, even without making any edits on the same program, we saw upwards of a 30 percent increase in throughput."

Sensing Improvements

Further development in sensor technology includes the ability to collect dimensional data without touching the part. In laser probing, a coherent light source is projected onto the part and the reflection is analyzed to record single points or a series of points, such as when using a scanning touch probe. Video systems, which can measure part edges accurately and capture smaller features than touch probes, employ a camera and an illumination system to record a number of data points simultaneously.



Carl Zeiss

Retrofitting a CMM with Windows-based software, like the Calypso package, lets a shop import CAD files, select areas to be measured and automatically create measuring programs, working offline if desired.

Noncontact sensors are best for measuring soft, malleable materials and small part features. Large-scale, moderate-precision inspections (such as the fit of automotive exterior panels) can be accomplished quickly by noncontact laser scanning. Shemenski said touch scanning would be overkill for such sheet metal applications, where accuracy requirements may be on the order of 10 to 20 times less precise than the under-2µm accuracy range typically required when inspecting an engine block.

Dennis Zayia, CMM product manager for Renishaw Inc., Hoffman Estates, Ill., said new scanning technology can bridge the traditional split in inspection functions, where touch probes are used for single-point size/location-type measurements, and scanning probes, with their ability to quickly capture many points, are preferred for shape/form-type calculations. Zayia said new Renishaw scanning technologies greatly increase scanning speeds over traditional methods, while maintaining a touch probe's ability to measure individual data points quickly.

Speed increases in the scanning mode can be significant. Previously, when trying to increase scanning speeds, machine momentum and inertia degraded measurement accuracy. As the CMM moved the probe across the part and changed direction, varying motion-induced errors occurred. "This effectively limited scanning speeds to less than 20 mm/sec.," said Zayia.

To minimize dynamic factors, Renishaw has developed new software and hardware, including a 2-axis, infinite-positioning head. The company recently introduced a system consisting of a 5-axis Renscan5 machine control, a Revo high-speed scanning head, a laser-corrected probe and a UCC2 universal CMM controller. The company says the combined technologies provide greater data coverage to meet tighter part specifications while measuring at speeds up to 500 mm/sec.

Multiple Benefits

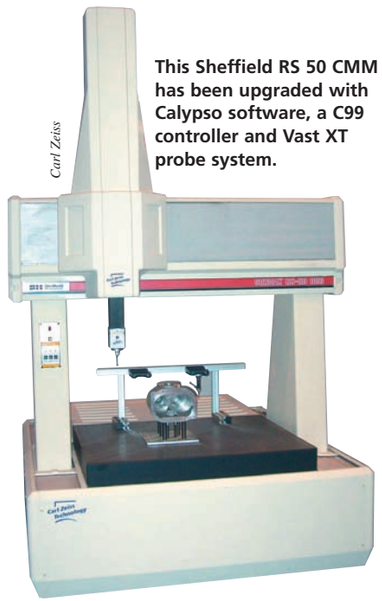
Just as multifunction machine tools combine software and toolchangers to permit processing of a part in one fixturing, CMMs with multiple sensing technologies can permit inspection of multiple part features on one machine. This saves time and effort spent moving a part from machine to machine, and minimizes the chance for part damage and measurement errors. Bill Gilman, vice president of North American sales for Optical Gaging Products Inc. (OGP), Rochester, N.Y., asked, "If you can machine a block of metal on a 5-axis machine tool and get a complex part at the end of the process, why not measure that part in a similar way?"

Gilman expressed concerns, however, about retrofitting an old CMM with multiple sensor technologies. While upgrades from single-point to scanning touch probes are common, there are limitations to adding vision sensing to a CMM. "A video sensor is generally much heavier than a touch-probe unit, and the mechanism isn't designed to support that weight," he said. Video systems also require special lighting that is not found on a touch-probe CMM.

Integration of touch probe and vision software also is an issue. While a touch-probe CMM processes single points or a series of points, in a video system "you have a camera looking at an array of points all at once, not a single point," Gilman said. Sensor integration in the metrology software isimportant, "so we can switch between onesensor and the other during the measurement without having to stop, recalibrate the other sensor, and then do the measurement," he said.

OGP tends to "approach it from the other direction," Gilman said, preferring to add single-point recognition sensors to a video machine rather than the other way around. Video system machines, engineered to deal with multiple points simultaneously, can handle single-point and scanning input as well. "Our multisensor machines are vision-based machines that can have touch probes, lasers and other kinds of sensors added to them. We have cases where there are four or five sensors on a given platform."

An integrated multisensor system offers significant productivity improvements. "You fixture the part once," Gilman said. "You use video in all the places where you can use video. In certain places, like the bottom of


Carl Zeiss

This Sheffield RS 50 CMM has been upgraded with Calypso software, a C99 controller and Vast XT probe system.

The following companies contributed to this report:

Carl Zeiss IMT Corp.
(763) 744-2400
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Optical Gaging Products Inc.
(800) OGP-GAGE
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Renishaw Inc.
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Wilcox Associates Inc.
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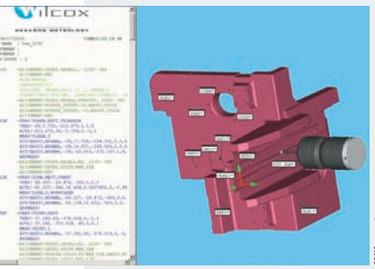
In-process metrology on a CNC machine

The measurement and probing technology employed on a machine tool typically does not offer the level of accuracy possible with a dedicated CMM.

Steve Logee, director of business development for Wilcox Associates Inc., a Hexagon Metrology company, North Kingston, R.I., said, "It is possible to calibrate a machine tool so that it becomes, in essence, a CMM, but this is not necessarily desirable. How you expect to use the measurement results should be the determining factor."



Wilcox Assoc.

In-process metrology software permits checking of key features directly on probe-enabled CNC machines.

He said there are compelling reasons to use a CNC machine for precise inspection. Having a machine sit idle while a first-item part is taken to the inspection room, fixtured and inspected interrupts production and wastes machine time. Large parts can present additional problems, as they are difficult to transport for inspection and may actually challenge the capacity of a shop's CMM. Another consideration is the cost of making fixtures for both the machine tool and the CMM.

However, Logee said, "before using a CNC machine to measure anything, you need to ensure it is calibrated and working within its specification. Then you need to determine if, given its resolution, it is capable of measuring to your required tolerances. In many cases, this is all you have to do to take the kinds of measurements you need. But if you expect more, then you must go a bit further."

To get true CMM-quality measurements, it is necessary to compensate for a machine tool's linear and volumetric errors. Subsequently, the machine tool operates in two separate, mutually exclusive modes. "When measuring, it is a CMM, and when cutting, it is a CNC machine," Logee said. "In the first mode, it makes full use of error compensation and you can use it to measure parts produced on it. When it cuts, it works the way it always has." He cautioned that to maintain CMM capability it is necessary to re-create the CMM error compensation files anytime adjustments are made to the physical characteristics of the machine tool.

In most cases, a CNC machine doesn't have to become a fully functional CMM. Rather, it can be used to check a few key part dimensions, thereby minimizing scrap and rework.

Logee suggested a possible technique for increasing machine accuracy for a run of specific parts. After measuring a completed and correct part on a CMM, it should be measured again on the machine tool, using its standard probes and software without any special error compensation. The differences in the CMM and on-machine measurements can be used to adjust the machine tool's CNC program.

Because such adjustments can be time-consuming if they require writing macros for every probing operation on the machine tool, Logee recommended a dedicated in-process metrology program like PC-DMIS NC, which enables users to take full advantage of their on-machine probing systems with the sophisticated capabilities of a true metrology system.

—B. Kennedy

a bore, where optics can't focus deep enough, you might go down with a touch probe and grab some points that way. Then, for a complex surface form that doesn't have a nice geometric CAD design, you might scan across the surface with a laser." The points gathered are analyzed in one software package and the results are compared with the original CAD file to confirm if the part is correct.

Zeiss' Shemenski said measurement of semimetal head gaskets is a good example of a multisensor application. He said: "You've got gasket material on a metal substrate. You've got features you definitely want to take a tactile probe to measure, such as hole diameters. There also are some soft features you can't measure with that tactile probe, and if you have a CMM with the right technology, you can switch out to the camera probe and take some digital imaging seamlessly."

Renishaw

The 2-axis Revo high-speed scanning head is part of a system that can enable a CMM to measure at speeds up to 500 mm/sec., according to Renishaw.

OGP's Gilman believes it is possible to group some capabilities on one machine and significantly reduce the need to use a separate measuring machine for every distinct part feature. "Utopia would be one machine that you would put the part into, press a button and get all your measurement results," he said, adding that "it is notlikely there will be one machine that will replace all these independent machines." △